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Silicon Photonics Integrated Circuits for 5th Generation mm-Wave Wireless Communications

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Silicon Photonics Integrated Circuits for 5th Generation mm-Wave Wireless Communications

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Introduction & Motivation

Hybrid *photonic-wireless transmission* schemes in the mm-wave frequency range are promising candidates to enable the *multi-gigabit per second data communications* required from *wireless and mobile networks* of the 5th and future generations. *Photonic integration* may pave the way to practical applicability of such photonic-wireless hybrid links by *reduction* in complexity, size and – most importantly – *cost*.

Silicon Photonic Integrated Circuits

Why Silicon Photonic Integrated Circuits?

Silicon-on-insulator (SOI) photonic integrated circuits (PICs) are a prime candidate for photonic integration, due to a number of factors:

- Compatible to CMOS technology and fabrication infrastructure
  - Highly accurate, high-yield and mature technology
  - Hybrid photonic and electronic integration
- Operation in the 1.3µm and 1.55µm telecommunications windows
- Large selection of photonic components available
  - Filters
  - Modulators
  - (De-)Multiplexers
  - Mach-Zehnder Interferometers
  - Splitters
  - Photodetectors
- Active components with heterogeneous integration (III/V, InP etc)

Integration of mm-Wave Transmitter

Silicon photonic integrated circuits allow integration of the mm-wave generation setup, including generation of a wavelength comb or two appropriately spaced spectral lines and the modulation for data transmission or sensing.

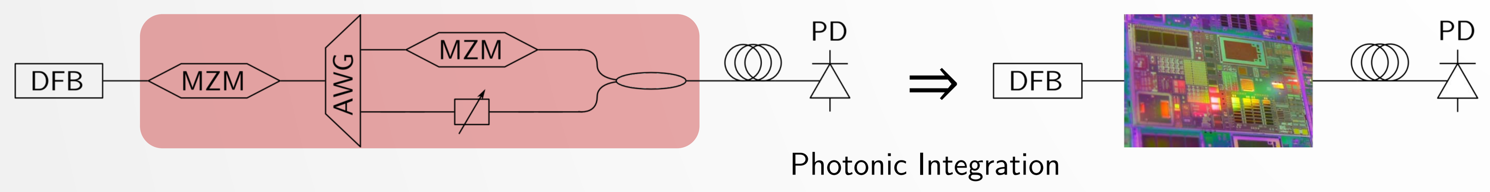

Figure 1. Schematic transmitter setup for a high-capacity hybrid fibre-wireless data communication link and potential for photonic integration

millimeter Wave Silicon Photonics for Remote Sensing and Wireless Links

Project Goals

The project will demonstrate that mm-wave transmissions based on silicon photonic integrated circuits may enable the ubiquitous high-speed wireless networks of the future. To this end the steps and goals of the project are:

- Design and test of a PIC for mm-wave signal generation
- Photodiode design and test for mm-wave OE-conversion
- Demonstration of a high speed mm-wave wireless link supporting 100Gbit/s or more

mmW-SPRAWL

AARHUS UNIVERSITY

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2014 – 2018

Photonic-Wireless mm-Wave Systems

Applications

The large bandwidth made available by the use of mm-waves and the flexibility of hybrid photonic-wireless systems benefits not only data communications but also a large range of applications in radar and sensing:

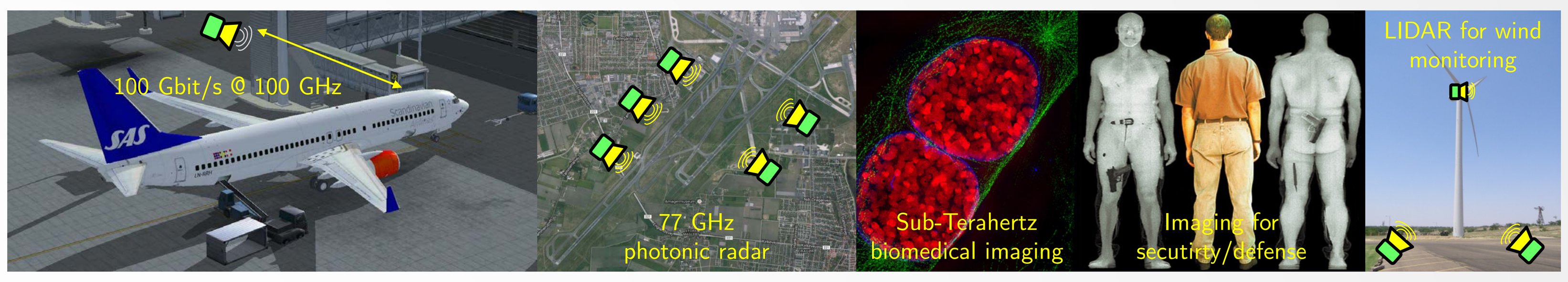

Figure 2. Applications and use cases for mm-waves

System Architectures

Optical generation and delivery of the RF signal to the antenna site allows easy realisation of system setups for both communications and sensing.

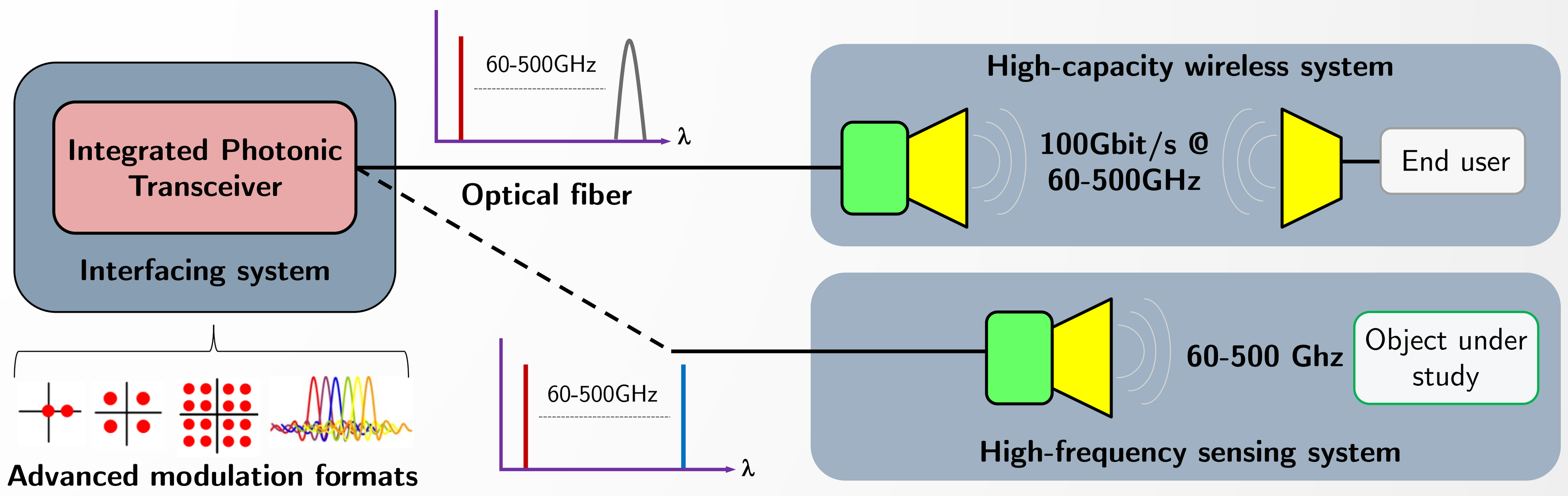

Figure 3. System setups for radio-over-fibre communication and sensing systems

mm-Wave Wireless Transmission

Wireless transmission in the W-band based on discrete optical components is demonstrated in the lab at distances up to 70m.

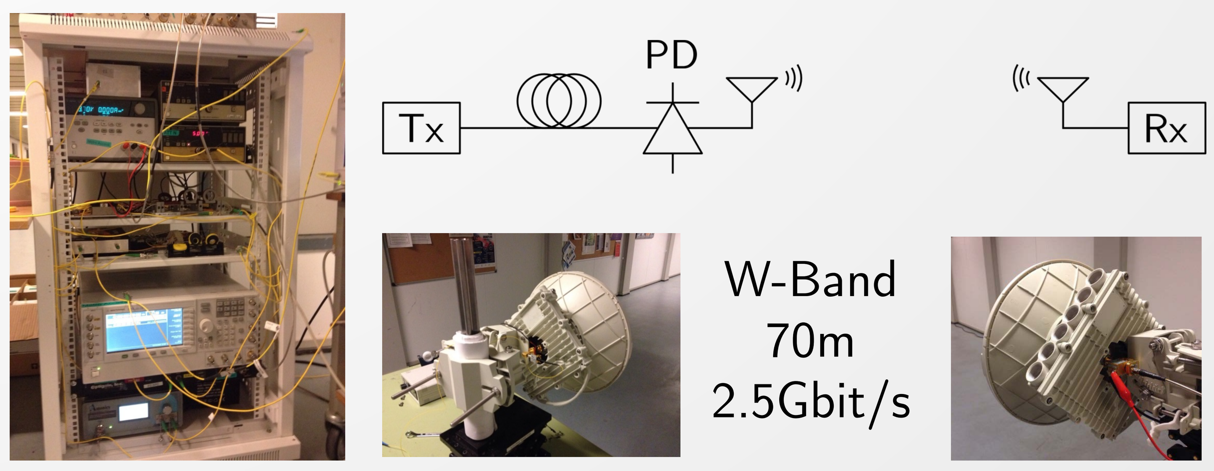

Figure 4. W-band wireless transmission system schematic and experimental setup

Transmission of higher data rates and with less directive antennas requires a characterization of the wireless channel in the W-band.

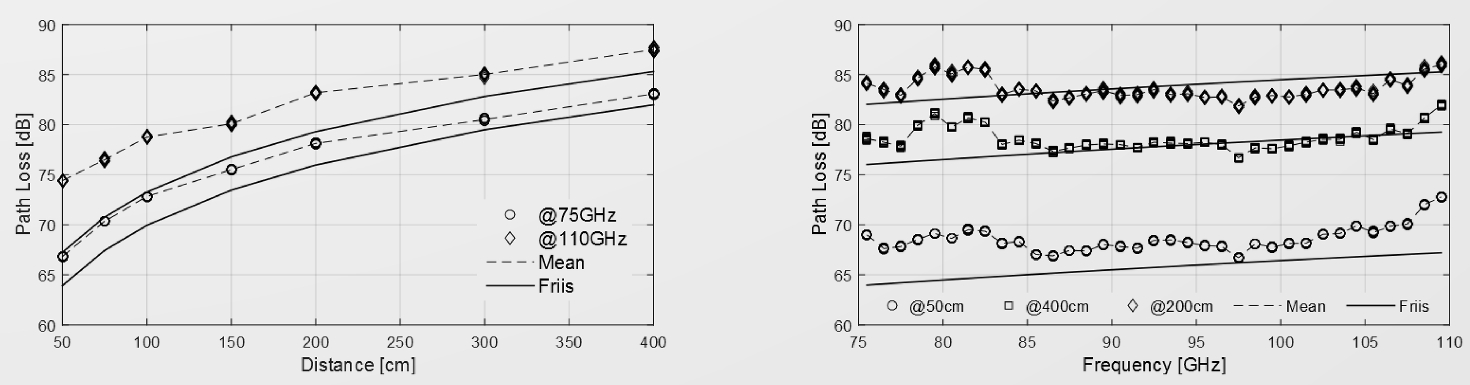

Figure 5. Large scale fading behavior of the W-band wireless channel, showing good agreement with the Friis loss model

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